

Ancillary Services Workshop

Presented to:

RTO West Ancillary Services Work Group

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Introduction

During the first portion of today's workshop, we will review two factors that will affect the design of all ancillary services markets.

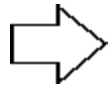
- **First, we will discuss the contents of Order 2000, which places certain requirements on RTOs regarding ancillary services.**
- **Next, we will discuss the other objectives that should guide the design of any market.**

Introduction

Then we will discuss how to answer the following questions regarding markets for ancillary services:

- **Which ancillary services will be offered by the RTO?**
- **How will control area operators coordinate their operations to permit this?**
- **Which ancillary services can be supplied competitively?**
- **How will demand for ancillary services be determined?**
- **How will suppliers of ancillary services be selected?**
- **What will those suppliers be paid?**
- **What incentives will those suppliers have to fulfill their obligations?**
- **How will responsibility for paying for or providing each service be allocated?**

Agenda



- **Order 2000 and its Implications for Ancillary Services Markets**
- **Other Objectives When Designing Competitive Markets**
- **Determining Which Ancillary Services to Offer**
- **Coordinating Activities of Control Area Operators**
- **Determining Demand for Ancillary Services**
- **Selecting Suppliers of Ancillary Services**
- **Calculating Payments to Suppliers of Ancillary Services**
- **Alternatives When Competitive Markets Are Difficult to Create**
- **Incentives for Suppliers of Ancillary Services to Fulfill Their Obligations**
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What Order 2000 Requires

Order 2000 requires each RTO to “serve as the supplier of last resort of all ancillary services required by Order No. 888 and subsequent orders.”

- **However, the RTO is not actually required to supply these ancillary service itself, since that would require it to own or operate resources that supply ancillary services.**
- **FERC did not revise the list of services that the RTO is required to offer that was included in Order 888, although RTOs are permitted to propose other services.**

What Order 2000 Requires

RTOs are permitted to fulfill ancillary service obligations through a variety of mechanisms, including:

- **Contractual arrangements.**
- **Indirect or direct control of specified generation facilities.**
- **Market mechanisms.**

However, regardless of which method an RTO adopts, “the ancillary services must be included in the RTO administered tariff so that transmission customers will have access to one-stop shopping for transmission service.”

The RTO also “must promote the development of competitive markets for ancillary services wherever possible.”

What Order 2000 Requires

RTOs must permit market participants to self-supply their ancillary service requirements, or alternatively, to acquire those requirements from third parties.

- **But the RTO must verify that such market participants have acquired the required amount of those ancillary services.**

And the Order states that “the RTO must have the authority to decide the minimum required amounts of each ancillary service and, if necessary, the locations at which these services must be supplied.”

What Order 2000 Requires

Additionally, the RTO must ensure that its transmission customers have access to real-time balancing markets, as of RTO start-up.

- **The RTO can operate these markets itself.**
- **Or another entity can operate them, if that entity is independent of all market participants.**
- **Other market participants are free to operate their own balancing markets, but an RTO cannot rely on the existence of such a market to fulfill Order 2000's criteria.**

What Order 2000 Requires

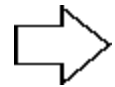
FERC did not prescribe whether the real-time balancing market would be available for all imbalances or only for imbalances within a specified band.

- **RTOs must present justification for the choice they make.**

Finally, with regard to imbalances:

- **FERC stated that no distinction should be made between the responsibility of loads and generation for imbalances.**
- **However, penalty mechanisms for imbalances may differ between loads and generators.**

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Fundamentals of Designing Competitive Markets

Most markets do not have to be designed.

- Externalities in these markets are minor (or the impact of those externalities is regulated in some way).
- Time constraints are less critical than in electricity markets.
- As a result, we can rely on bilateral trading among market participants.

However, in electricity, these conditions do not apply.

- Interconnectedness leads to large externalities, because one participant's actions can significantly affect reliability for all.
- The need to balance generation and load at all times without violating transmission limits requires some degree of coordination.

This means that a centralized market is required for at least some services. And that means that it is necessary to design that market.

Other Objectives

In addition to the requirements that the RTO comply with Order 2000, there are a number of other criteria that the congestion management and imbalances markets operating under the RTO should meet, some of which will be of great importance to many of you.

- **They should be efficient.**
- **They should ensure reliability.**
- **They should be open and non-discriminatory.**
- **They should not expose market participants to unpredictable and unhedgeable costs.**
- **They should be liquid.**
- **They should be sufficiently flexible to accommodate many forms of trading.**

Efficiency and the Advantages of Markets

The same benefits can result from establishing electricity markets that result from markets for other goods and services:

- **More efficient suppliers will be more profitable.**
- **Costs to end users will fall as the result of:**
 - *Pressure on all competitors to lower their costs.*
 - *Squeezing out less competitive suppliers.*
 - *Increased gains to trade.*
 - *Innovation in the supply of services.*

But in order to reap as much as possible of the rewards that flow from the creation of markets, these markets must be *efficient*.

Efficiency and the Advantages of Markets

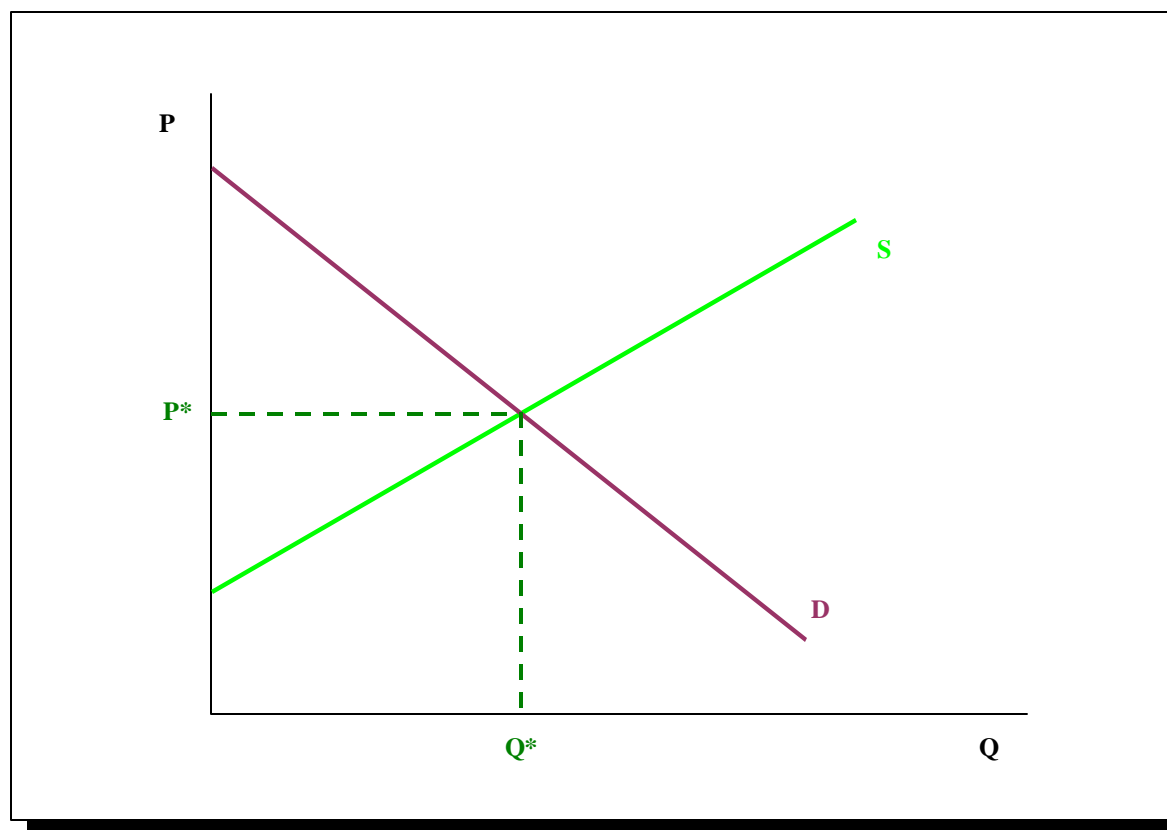
If a market is efficient, then it supplies products to meet the needs of customers at the lowest possible cost.

Of course, no market is perfectly efficient, but some market designs give better incentives for efficiency than do others.

- **Efficiently functioning markets will do the most good for the greatest number of market participants.**
- **Efficiency is the foundation for most of Order 2000's directives for RTOs.**

Efficiency and the Advantages of Markets

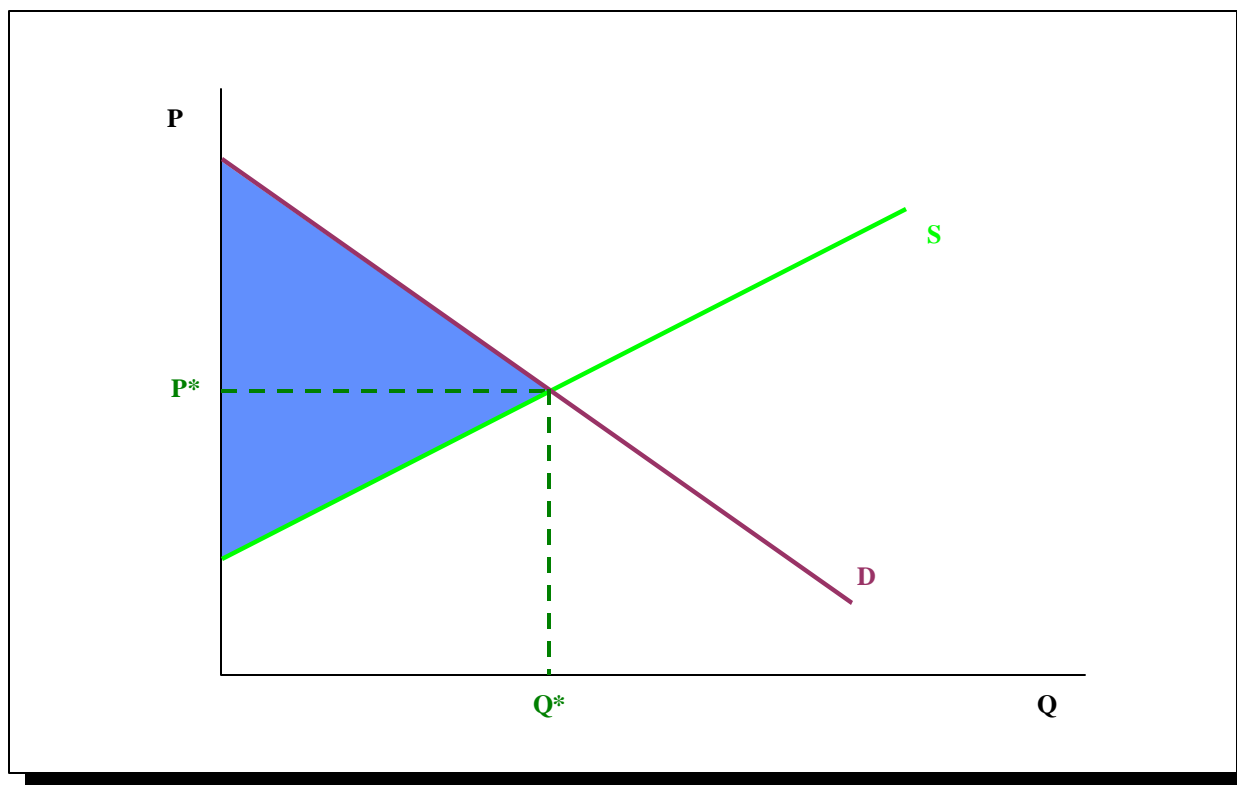
In markets that do not require central coordination, an equilibrium occurs at the intersection of supply and demand curves.



Efficiency and the Advantages of Markets

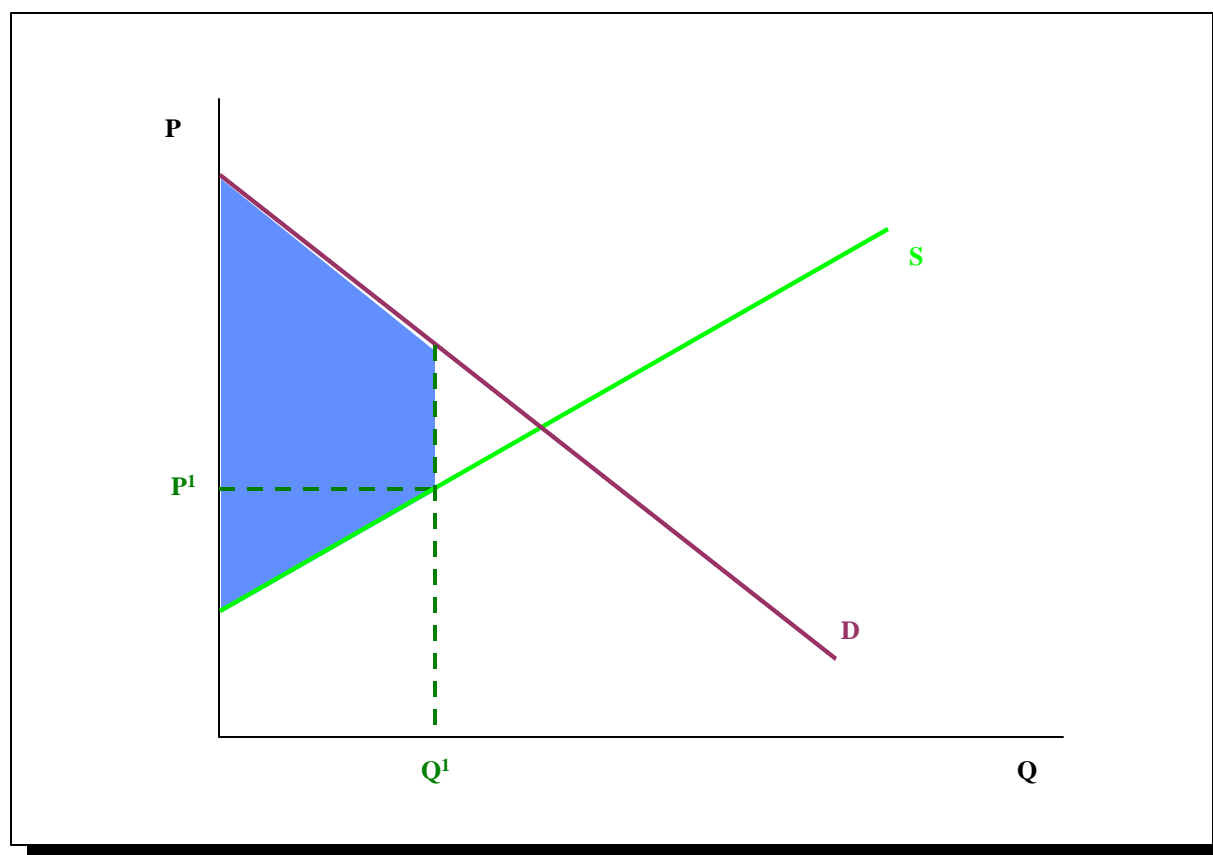
That price and that quantity maximize gains from trade.

- **Gains from trade are the amount consumers would have been willing to pay for the goods they purchased, less the amount that it actually cost producers to produce those goods.**



Efficiency and the Advantages of Markets

At any other price and quantity, gains from trade will not be maximized. It is still possible for market participants to make additional trades, to their mutual advantage.



Efficiency and the Advantages of Markets

Designers of markets attempt to encourage this competitive outcome.

- **If they fail to do so, resources will be wasted, and additional mutually beneficial (i.e., profitable) trades will not have been consummated.**

Beneficiaries of Efficient Markets

Efficiently functioning markets may not be in the interest of everyone in this room.

- In fact, each representative of a market participant in this room may have a financial interest in making some part of this market inefficient--especially if the inefficiency would subsidize them, while spreading the cost across other market participants.
- However, efficiently functioning markets will do the most good for the greatest number of market participants.

Accordingly, the key criterion by which to judge the design of a market, and the key criterion by which FERC will judge the design of markets that each RTO proposes, is the degree to which that design promotes efficiency in:

- Minimizing the cost of providing ancillary services, given resources currently available.
- Providing appropriate incentives for capital investment.

Reliability

The RTO must ensure that the ability of system operators to meet reliability criteria is not compromised.

- It should be in the economic interest of market participants to act in ways that support reliability, instead of undermining it.
- The market design should not simply assume that vital reliability functions will be performed by someone, without specifying:
 - *Who will perform those functions.*
 - *Why they will perform them.*
- It also should not complicate the the system operator's job to the extent that reliability is endangered.

Non-Discriminatory Access

Another important factor is the degree to which the market facilitates comparable and non-discriminatory access.

- **The amount that each market participant is charged for use of the system or for a service, or the responsibilities placed upon a market participant, should not depend on who that market participant is.**
- **The ability of each market participant to schedule use of the transmission system should not depend on who that market participant is.**
- **Pricing should be as transparent as possible, and pertinent information (e.g., information on constraints) should be publicly posted.**
- **Participation by small entities should not be unnecessarily restricted.**
- **The market should not discourage entry of new competitors by treating entrants and incumbents differently.**

Exposure to Unhedgeable Costs

Market participants should not be exposed to unpredictable and unhedgeable costs.

- It should incorporate mechanisms that will mitigate cost shifts.
- It should not expose market participants to any other significant costs that cannot be hedged, such as unreasonable uplift costs.
- It should not expose providers of last resort to unrecoverable costs.

Liquidity

The congestion management and imbalances markets that operate under the RTO should be liquid.

- They should permit the establishment of mechanisms that permit markets to be more thickly traded.
- The market should be as seamless as possible. Barriers to trading between control areas within the RTO, and between the RTO and adjoining regions, should be eliminated to the extent possible.

Flexibility

Finally, markets should be sufficiently flexible to accommodate many forms of trading.

- **The participation of entities such as independent ancillary services exchanges should be accommodated.**
- **At the same time, however, market participants should not be forced to use intermediaries (unless there is an economic basis for such requirements).**
- **The market structure should neither drive participants toward nor away from participating in independent power exchanges, self-supplying, or acquiring ancillary services in other bilateral transactions.**

Implementation Speed

Two final factors to keep in mind are speed of implementation and transitional issues.

While the deadlines that FERC set are important, they can be over-emphasized.

- **FERC will prefer a market that is consistent with Order 2000's objectives but which does not meet Order 2000's deadlines to a market that meets the deadlines but is inconsistent with its objectives.**

Interim Markets

It may be necessary to adopt interim market designs that differ from the end-state design.

- **The interim decisions must be made with the end-state design in mind.**
- **Radical shifts between interim design and end-state design will cause problems.**

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Ancillary Services Identified in Order 888

In Order 888, FERC identified the following ancillary services:

- **Scheduling, system control and dispatch**
- **Reactive supply and voltage control**
- **Regulation and frequency response**
- **Spinning reserve**
- **Operating reserve**
- **Energy imbalances**

Additional Ancillary Services

NERC has defined the following additional services (which it refers to as Interconnected Operations Services):

- **Black start**
- **Loss compensation**
- **Dynamic scheduling**
- **Backup support**
- **Load following**

And there has been subdivision of some previously defined services.

- **California has defined separate markets for upward and downward regulation.**
- **Many markets have defined separate categories of operating reserves.**

What Order 2000 Requires

Order 2000 requires the RTO to offer the six ancillary services that were listed in Order 888.

But Order 2000 also permits the RTO to offer additional ancillary services. Which services should it offer?

- **It may be easier to address this question by discussing what the RTO should *not* do.**

Combining Services That Should Be Separated

First, to the extent possible, it should not mash together services if the needs for those services are really separate.

- **For example, in some areas, needs for regulation and load following can be identified independently.**
 - *Regulation is intended to follow minute-to-minute perturbations in system load.*
 - *Load following capability is needed to follow larger swings in load, such as the morning pickup.*
- **If regulating units are used to supply load following capability, the system may be acquiring more regulating capability than is needed.**
 - *A better solution would be to define separate regulation and load following requirements, while permitting regulation to substitute for load following.*

Mandating Provision of Services

Second, it should not mandate the provision of services.

- **For example, suppose that every owner of generation was required to supply reserves.**
 - *This will not be the most efficient way to procure reserves.*
 - *Recall that the reason for instituting markets was to permit gains from trade. This prohibits trade.*
 - *Also, if such provisions are applied to only some generators (e.g., generators on dispatch, or generators with certain equipment installed), it will give them an incentive to evade this requirement.*

Ignoring the Service

Third, it should not ignore the service.

- **If the service is needed, then the RTO cannot simply assume that entities who have supplied the service in the past will continue to do so.**
 - ***The financial incentives for such entities have changed significantly over time.***

Dividing Markets to Enhance Efficiency

Differences in suppliers' ability to supply a service may also make it advisable to separate markets. For example:

- **Suppose that a market's regulation requirement is 100 MW, upwards or downwards.**
- **But the upward regulating capability of many units differs from their downward regulating capability.**
- **Then it may make sense to define separate markets for upward and downward regulation.**
- **It would also make sense to define separate markets for upward and downward regulation if the total amount of upward regulation needed was not the same as the total amount of downward regulation needed.**

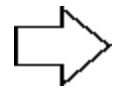
Start-Up Issues

It is possible, however, that not all of the services you decide should be defined can be defined as of the date of RTO startup.

As we will discuss later in this presentation, in order to create an effective market for an ancillary service, there must be effective ways of:

- **Determining requirements for that service,**
- **Monitoring the performance of suppliers of that service, and**
- **Mitigating any market power for that service.**

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What Order 2000 Says

The creation of RTO-wide markets for some ancillary services brings up other questions regarding how those markets will be implemented, given the current control area divisions.

- **Order 2000 states that “all generators or other facilities that supply ancillary services must be subject to direct or indirect operational control by the RTO.”**
- **This means that ancillary services in the area to be covered by RTO West cannot be handled as transactions between control area operators, because that would not permit the implementation of RTO-wide markets.**

Creating a Single Control Area

There are several alternatives available. One would be the creation of a single control area covering all of RTO West.

- **This would be the simplest option, from the perspective of designing ancillary service markets for the RTO.**
- **It may not be the simplest, nor even desirable, from some other perspectives.**
- **And it may not be feasible for the roll-out of the RTO, given the time constraints.**

Defining Independent Control Area Markets

Another option would be to define ancillary service requirements on a control area basis.

- **This would essentially create separate ancillary service markets for each control area, since ancillary service suppliers would be identified separately for each control area to meet requirements for that control area.**
- **As a result, it will not facilitate sales of ancillary services from entities within the RTO's area to outside the RTO (or vice versa).**

Defining Independent Control Area Markets

Order 2000 does give the RTO the authority to “decide ..., if necessary, the locations at which ... [ancillary] services must be supplied”.

- **This constraint might pass muster under this provision.**
- **However, it seems likely that FERC had physical constraints in mind when it gave RTOs this power.**
- **A constraint based on the desire not to revise inter-control area operating agreements may be “necessary” in the short term, but is unlikely to meet this test in the long term.**

These constraints could also make the ancillary services markets less efficient.

- **Consolidation of some control areas would reduce these inefficiencies, but it would not eliminate them.**

Defining Independent Control Area Markets

This proposal also raises questions regarding who would control providers of the service.

- **Would the providers of the service be under the control of the RTO?**
- **Or would they be under the control of the control area operator?**
 - *This raises conflict issues.*
 - *But it will be more consistent with current practices.*

Also, the RTO would need some way to verify provider performance.

Frequent Modification of Inter-Control Area Schedules

A third option would require that the operators of the control areas that make up RTO West modify schedules on a short-term basis.

- **Ancillary services suppliers would be selected on an RTO-wide basis, and would be under RTO control as necessary to meet RTO-wide needs.**
 - *The RTO would need some way of doing this, and of assessing that individual suppliers of services met their obligations.*
- **Control area operators would need to be able to modify inter-control area schedules frequently in order to permit RTO-wide markets for some ancillary services.**

Frequent Modification of Inter-Control Area Schedules

The minimum frequency with which modification of these inter-control area schedules would be necessary may vary depending on the service.

- In order to provide an RTO-wide regulation market, it would be necessary for these schedules to be modified dynamically.
- RTO-wide markets for operating reserves might not require dynamic modification.

This ability may not be needed for some ancillary services.

- Markets for those services could be conducted on an RTO-wide basis, even if procedures to modify inter-control area schedules frequently are not developed.

Frequent Modification of Inter-Control Area Schedules

Implementing Order 2000's requirement for RTOs to operate regional real-time balancing markets for energy may require control area operators to permit frequent schedule modifications.

- **Order 2000 does not require the RTO to operate a single control area.**
- **But it does require the RTO to “have sufficient operational authority to ensure that a real-time balancing market can be implemented.”**

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Determining Demand for Ancillary Services

Order 2000 requires that “the RTO ... have the authority to decide the minimum required amounts of each ancillary service.”

In most areas, the amount of an ancillary service demanded has been set using engineering criteria, often in response to NERC or regional reliability council requirements.

- **E.g., operating reserve requirements may be based upon the largest amount of generating capacity that can be lost in a contingency.**

These requirements ensure a certain level of service reliability for customers.

Permitting Demand to Respond to Price

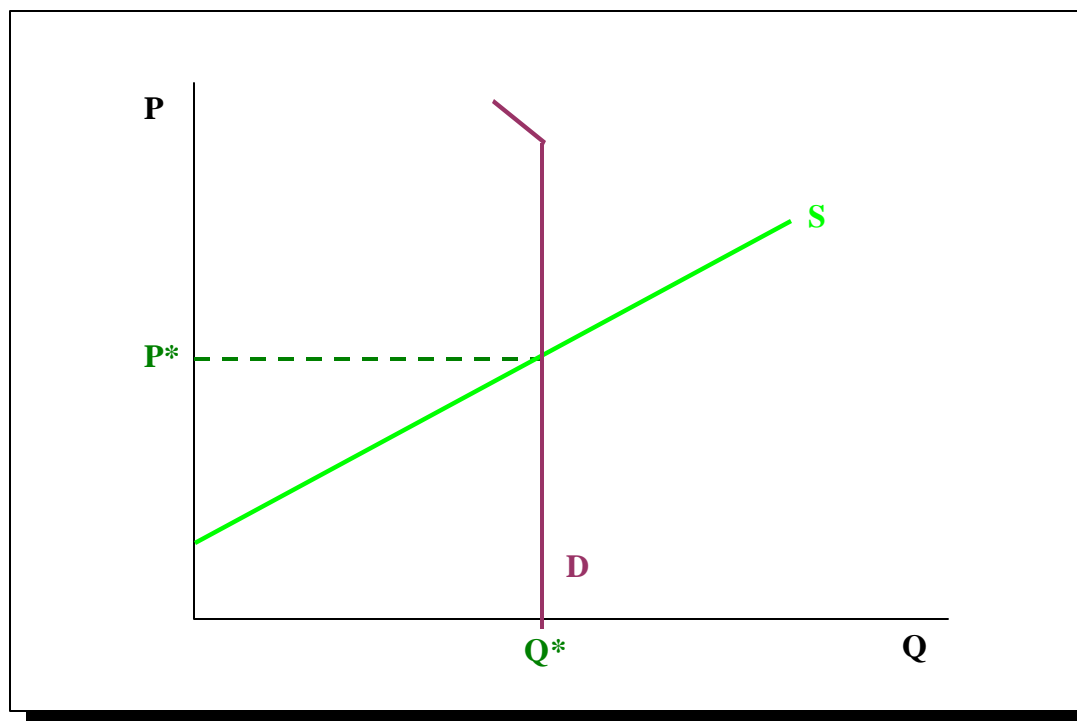
In some cases, when the prices of ancillary services become very high, it may become worthwhile to reduce the amount of the service purchased.

- **This may also yield large cost savings.**

Demand Curves for Ancillary Services

The best way to implement this policy is to introduce a demand curve into the ancillary services market.

- Under this approach, if the price of an ancillary service climbed above a certain level, the amount of the service purchased would decrease as the price increases.



Demand Curves for Ancillary Services

The trade-off between the price of a service and the amount of that service that is purchased would be the subject of debate.

- **However, the alternative is to assume that consumers are willing to pay any price for the required minimum amount of an ancillary service, and nothing above that level.**
- **It is very unlikely that customers' demand curves look like that.**

Practices in Other Markets

Most markets have started out by stating ancillary services requirements in fixed terms, rather than specifying demand curves.

- **This was the approach used in California, PJM, New York, and New England (as well as in the IndeGO proposal).**
- **The lack of demand responsiveness to price is one of the factors that has made ancillary services markets notoriously subject to price spikes and the exercise of market power.**
- **Price caps can be seen as a crude way of implementing demand curves for ancillary services.**
- **Further investigation into using demand curves to specify ancillary service requirements is ongoing in New York and New England.**

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What Order 2000 Requires

Merely because a competitive market can be established for an ancillary service does not necessarily imply that any way of designing a market will result in competitive markets for that service.

- **Ill-conceived systems for selecting suppliers of ancillary services may lead to inefficient selection of suppliers, which will undermine the RTO's market.**
- **Therefore, Order 2000's requirement that RTOs promote the development of competitive markets for ancillary services implicitly requires RTOs to develop markets that efficiently select suppliers of ancillary services.**

Key Criteria

The following questions must be answered in order to determine how to select suppliers of an ancillary service.

- **How will competitive markets for those services be structured?**
- **How will markets for an ancillary service be linked to markets for other ancillary services?**
- **When will those markets operate?**
- **How will an entity that wishes to supply an ancillary service be permitted to bid into the market for that service?**
- **How will locational constraints upon the supply of ancillary services affect markets?**

These questions hold regardless of whether ancillary services markets are defined on an RTO-wide basis or for individual control areas.

Market Structure Proposed in IndeGO

The IndeGO proposal envisioned balancing markets for ancillary services conducted by the RTO.

- **Most ancillary services would be procured outside the RTO-coordinated markets.**
- **Residual obligations are covered by purchases in a market conducted by the RTO.**
- **This emphasis on procuring most services outside the RTO is similar to ancillary service markets proposed in MISO or Desert STAR.**

Efficient markets for ancillary services can be designed using this approach.

When Central Markets Are Unnecessary

In some cases, there is no need for a central market for an ancillary service.

For example, consider a situation in which:

- **All market participants know their respective responsibilities to acquire a service in advance, and**
- **There is no need to verify that each market participant has fulfilled its obligation.**

In that case, each market participant can be left to “self-supply”; i.e., to supply its own services (or purchase services from third parties, including ancillary services exchanges) to satisfy its own requirement.

- **There is no need to establish a marketplace--although one may spring up to facilitate trade among market participants.**

When Central Markets Are Needed

However, development of some sort of a central market for an ancillary service becomes more important if:

- **The total amount of the service that must be acquired, or each market participant's share of that requirement, is not known in advance.**
- **The total amount of the service that must be acquired from suppliers located in a certain area, or each market participant's share of such a requirement, is not known in advance.**
- **It is necessary to verify that each market participant has supplied its share of the requirement, in order to avoid adverse consequences for system reliability.**

When Central Markets Are Needed

At the least, it will be necessary for the RTO to conduct real-time markets to ensure that adequate ancillary services are provided to meet the RTO's requirements.

The question then becomes whether the ability to participate in this market should be restricted.

When Coordinated Markets Are Useful

Generally, there is no reason to limit participation.

- If market participants' responsibilities are (or can be) based on actual consumption, then it may be very difficult for each market participant to self-supply its requirement in advance, since that requirement is not known in advance.
 - *The market participant could buy far more of the service than it expects to need, but this will lead to inefficient expenditures on these services that will raise costs.*
- Therefore, the RTO-operated market could serve a valuable balancing function for market participants.
 - *Entities that purchased more of the service than they needed are compensated.*
 - *Entities that purchased less of a service than they needed are charged.*

None of this would preclude participation in ancillary services exchanges operated by entities unaffiliated with the RTO.

Operating an Efficient RTO Market

In order to give market participants efficient incentives to self-supply, the RTO-coordinated market must operate efficiently and must set prices correctly.

- **If the RTO-coordinated market does not function efficiently, market participants will be driven to self-supply even when less expensive resources are available in the RTO's market.**

In other words, the playing field should not be tilted towards either self-supplying one's obligation or purchasing from the RTO's market.

Ensuring Efficient Levels of Self-Supply

The following principles should be observed to ensure that the playing field is level:

- **Market participants that “self-supply” more of a service than is required to meet their obligations should be paid the market price of the excess.**
- **Market participants who do not “self-supply” enough of a service to meet their requirements should only be required to pay the market price for the remaining obligation.**

In other words, there should be no penalty imposed for participating in the RTO market, just as there would be no penalty imposed for not doing so. Violating these precepts will either:

- **Discourage market participants from self-supplying resources, or**
- **Inhibit the ability of the market to find more efficient ways of self-supplying a resource.**

Facilitating Self-Supply

One way to facilitate self-supply by market participants is to permit market participants to submit a price bid to the RTO market associated with the resource supplying that service.

- **The price indicates the minimum price at which that market participant wants to self-supply that resource.**
- **If the market price for that resource is lower than the price specified by that market participant, it does not self-supply, but instead purchases its requirement from the market.**
- **This allows it to avoid the risk that the market price is less than the cost of self-supply.**

How Should Ancillary Services Markets Be Linked?

There are two approaches that are currently used to determine how different ancillary services markets are linked.

One approach, which is used in California and was included in the IndeGO proposal, is to select the suppliers of ancillary services sequentially.

- **Under this approach, an order is determined for the ancillary services markets.**
 - *This order is generally based on which service can be substituted for other services.*
 - *The market for the most versatile--and hence most valuable--service occurs first.*
- **The first market is then conducted, with the objective of finding the most efficient method of providing that service.**
- **Subsequent markets follow in sequence. Each market determines the most efficient method of providing its service, given the decisions made in the preceding markets.**

Sequential Selection

In these markets, if a supplier's bid was not accepted to supply an ancillary service was not accepted in one market, it can use that capacity to supply other services in subsequent markets.

- **This is called “cascading”.**
- **Cascading can reduce the cost of providing ancillary services, by permitting generators to offer to supply more than one ancillary service with a given MW of capacity.**

Sequential Selection

Consider an example without cascading in which two ancillary services, regulation and spinning reserve, have been defined for a region.

- **50 MW of each are purchased in the RTO market.**
- **Generator A offers 50 MW of regulation at \$5/MW.**
 - *It would also be willing to use that capacity to supply spinning reserve for \$2/MW, but without cascading, it is only allowed to offer one service using that capacity.*
- **Generator B offers 50 MW of regulation at \$6/MW.**
 - *It would also be willing to use that capacity to supply spinning reserve for \$4/MW, but it is not permitted to do so.*
- **Finally, Generator C offers 50 MW of capacity to supply spinning reserve, at \$7/MW.**

Sequential Selection

In this example, the regulation market is first in the sequence.

- **Generator A's bid is lowest, so it is selected to supply 50 MW of regulation at a price of \$5/MW.**

Spinning reserve is next. Since Generator C is the only generator that has offered to supply spinning reserve, it is selected to supply 50 MW, at \$7/MW.

- **Generator B has spare capacity and would have been willing to supply spinning reserve at a lower cost, but the failure to cascade bids prevents it from doing so.**

Cascading Bids

Under cascading:

- **Generator A would be permitted to make the following offer:**
 - *50 MW can be used to supply regulation at \$5/MW.*
 - *Or that capacity, if it is not selected to supply regulation, can be used to supply spinning reserve for \$2/MW.*
- **And Generator B could make the following offers:**
 - *50 MW can be used to supply regulation at \$6/MW.*
 - *Or that capacity, if it is not selected to supply regulation, can be used to supply spinning reserve for \$4/MW.*

Cascading Bids

A more efficient solution results from cascading.

- **Generator A is still chosen to supply all 50 MW of regulation.**
- **However, Generator B is now chosen to supply 50 MW of spinning reserve, since its spinning reserve bid cascades into the spinning reserve market.**

This is a substantial improvement over sequential markets without cascading.

- **The total bid cost of providing regulation and spinning reserve is now $50 \text{ MW} \times \$5/\text{MW} + 50 \text{ MW} \times \$4/\text{MW} = \$450$.**
- **When suppliers were selected without cascading bids, the total bid cost of providing regulation and spinning reserve was $50 \text{ MW} \times \$5/\text{MW} + 50 \text{ MW} \times \$7/\text{MW} = \$600$.**

However, this is not the most efficient solution.

Demand Substitution

Another approach that the California ISO employs is demand substitution. Under this approach, the ISO will buy additional, higher-quality services if:

- **There is unused capacity for those services.**
- **The cost of purchasing those services is lower than the cost of purchasing the lower-quality services.**

So, in this example, if Generator B had bid \$7/MW to provide spinning reserve, then:

- **The RTO would have purchased a total of 100 MW of regulation--50 MW from Generator A and 50 MW from Generator B.**
- **This would have been cheaper than purchasing 50 MW of regulation and 50 MW of spinning reserve.**

Simultaneous Selection

Demand substitution should be included in market systems that clear sequentially, as it has the potential to increase efficiency.

However, it has no effect in this example.

- **Since Generator B's spinning reserve bid of \$4/MW is less than its regulation bid of \$6/MW, it is cheaper for the RTO to purchase 50 MW of regulation and 50 MW of spinning reserve than to purchase 100 MW of regulation.**

The most efficient solution to providing the necessary ancillary services will be found by conducting the regulation and spinning reserves markets simultaneously.

- **In other words, the suppliers of regulation and operating reserves would be selected with the objective of minimizing the total cost of providing both of these services.**

Simultaneous Selection

The simultaneous approach will select suppliers of these services more efficiently because the same resources can be used to supply the services.

- **The sequential approach will select a unit to supply regulation, without knowing its impact on subsequent markets.**
 - *This flaw is partially addressed by demand substitution, which takes the impact of scheduling additional regulation suppliers on subsequent markets into account.*
 - *But demand substitution does not consider the impact of the initial set of regulation suppliers on subsequent markets.*
- **Under the simultaneous approach, units are selected to provide services while taking into account the impact on all markets. No irreversible decisions are made in earlier markets.**

Simultaneous Selection

Under the simultaneous approach, Generator B would be selected to supply 50 MW of regulation, while Generator A would be selected to supply 50 MW of spinning reserve.

- **This increases the cost of providing regulation by \$1/MW, since Generator B bid \$6/MW to supply regulation, while Generator A offered to supply regulation for just \$5/MW.**
- **But it reduces the cost of providing spinning reserve by \$2/MW, since Generator A's \$2/MW bid to supply spinning reserve is \$2/MW below Generator B's \$4/MW bid.**
- **The net cost of providing regulation and spinning reserve combined decreases from \$450 to $50 \text{ MW} \times \$6/\text{MW} + 50 \text{ MW} \times \$2/\text{MW} = \$400$.**

Susceptibility to Exercise of Market Power

In addition to being more efficient, simultaneous selection may help reduce the opportunity to exercise market power, and it may enhance the RTO's ability to tell when market power has been exercised.

- **By reducing the amount of capacity available in individual markets, especially later markets, market power in those markets may be increased.**
- **Depending on how it is implemented, the sequential approach may discourage suppliers from bidding their actual costs.**
 - *If prices in later markets may be higher than prices in earlier markets, suppliers who submit lower bids in earlier markets may be penalized because they are selected in those markets, while other suppliers--who submitted higher bids and were less competitive--are paid more.*
 - *Suppliers will have an incentive to inflate their bids in earlier markets as a result.*
 - *The RTO will have difficulty distinguishing this behavior from bidding that is intended to cause prices to increase using market power.*

When Will Ancillary Services Markets Operate?

The RTO must operate a short-term ancillary services market.

- **This will enable it to acquire sufficient ancillary services to ensure reliability in case market participants do not self-supply.**
- **The time at which this market must be operated will depend on the service and the characteristics of the suppliers of that service.**
 - *If it is possible to arrange sufficient supply of a service an hour in advance, then the market only needs to be held an hour in advance.*
 - *If it requires a day to line up sufficient supply of a service, then the RTO will need to conduct a day-ahead market.*

When Will Ancillary Services Markets Operate?

The RTO may also operate longer-term ancillary services markets.

- **These would not be absolutely necessary for reliability, but they may be justified from the perspective of facilitating a more economic selection of ancillary services providers.**
- **The case for holding such markets interacts with the decision to conduct forward RTO energy markets.**
 - *Since the same resources are used to provide energy and ancillary services day-ahead, it makes sense to determine those providers jointly.*

How Will Potential Suppliers of a Service Be Permitted to Bid?

Often resources providing a service incur several different categories of costs.

- **For example, suppliers of regulation incur costs related to wear and tear on generation equipment.**
- **They also incur opportunity costs, if they are holding back capacity that could profitably be used to produce energy instead.**
- **And they may incur costs if the amount they are paid for producing energy exceeds the amount they are paid for producing that energy in the imbalances market.**

Different Approaches to Bid Structures

One approach is to require each bidder to internalize these costs.

- In other words, each prospective regulation supplier would have to guess at the opportunity costs it would incur.

An alternative approach would permit each such bidder to submit a different bid for each type of cost it incurs.

- The market operator would then select resources based on this information.

The second approach is likely to be more efficient.

- Under the first approach, the market operator must rely upon the guesses of market participants regarding matters beyond their control.
- Under the second approach, the RTO, which has more information regarding factors such as opportunity costs, can make those assessments itself.

Markets with Multiple-Part Bid Structures

Markets like this are already in effect in some areas. For example:

- **Bidders into regulation markets in PJM submit separate availability bids and energy bids.**
 - *This means that the availability bids only need to cover the cost of wear and tear, as the actual cost of operation is covered by the energy bids.*
 - *The ISO minimizes the cost of supplying ancillary services and energy, which means it trades off effects on availability costs for regulation against effects on energy costs.*
- **Bidders into operating reserves markets in the New York ISO also submit separate availability bids and energy bids.**
 - *The availability bids only need to cover the cost of having the machine available for operation, as the actual cost of operating it will be covered by the energy bids.*
 - *The ISO minimizes the cost of supplying operating reserves and energy, which means it trades off effects on availability costs for operating reserves against effects on energy costs.*

Interrelationship Between Bid Structure and Sequential/Simultaneous Selection

These bid structures assume that ancillary services markets (including markets for energy imbalances) clear simultaneously.

- **If the sequential approach is used, then, by definition, each market will ignore the effects of the selection of resources in that market on costs realized in other markets.**
- **If only some markets are cleared simultaneously (e.g., balancing markets are cleared first, and then other ancillary services markets are cleared simultaneously), then there will be a limited ability to incorporate this approach.**

Locational Constraints on Supply

In some cases, there can be locational constraints upon the selection of suppliers of ancillary services.

- **These limitations may result from the physical characteristics of the grid. For example, transmission limitations may make it necessary to carry a certain amount of operating reserves in a given area.**
- **Or they may result from other constraints. Limits on the ability to modify inter-control area schedules could force:**
 - *The requirement for an ancillary service be determined independently for each control area.*
 - *That requirement would then need to be met using only resources located in that control area.*

Accommodating Locational Constraints

One approach to accommodating locational constraints is to ignore them. And in fact, locational constraints are ignored in many markets.

- **Many locational constraints were effectively submerged by the procedures that vertically integrated utilities used to select ancillary service suppliers.**
- **The advent of competitive markets will give these companies financial incentives to change their procedures and lower their costs.**
- **But this will then cause previously submerged constraints to emerge.**
- **Locational constraints may be implicit in the selection of suppliers of services that are not procured competitively, such as reactive power and voltage support.**

Accommodating Locational Constraints

A better procedure is to recognize those locational constraints that exist, and to select the most efficient mix of ancillary service (and energy) suppliers, subject to those constraints.

Although it is unlikely that any market fully recognizes all locational constraints on the supply of ancillary services, locational constraints are explicitly recognized in some ancillary services markets:

- **Regulation and reserves markets in California.**
- **Some reserves markets in PJM, New York, and Ontario.**

The explicit recognition of these constraints will help to ensure reliability, and will also help when determining the market-clearing prices of these services, which will need to vary locationally in order for the markets to function efficiently.

Agenda

- **Order 2000 and its Implications for Ancillary Services Markets**
- **Other Objectives When Designing Competitive Markets**
- **Determining Which Ancillary Services to Offer**
- **Coordinating Activities of Control Area Operators**
- **Determining Demand for Ancillary Services**
- **Selecting Suppliers of Ancillary Services**
- ➡ • **Calculating Payments to Suppliers of Ancillary Services**
- **Alternatives When Competitive Markets Are Difficult to Create**
- **Incentives for Suppliers of Ancillary Services to Fulfill Their Obligations**
- **Allocating Responsibility for Providing Ancillary Services**
- **Questions You Must Answer This Summer**

How should suppliers of a service be paid?

In competitive markets, proposals for mechanisms to determine how much suppliers of an ancillary service can be separated into the two following camps:

- **Pay each supplier the market-clearing price for the service it supplies.**
- **Pay suppliers something other than the market-clearing price.**

Of course, the pricing mechanism will not directly affect market participants that self-supply an ancillary service.

- **But it will affect them indirectly, because the price they would pay in the market will determine the attractiveness of the self-supply option.**

Paying Bids

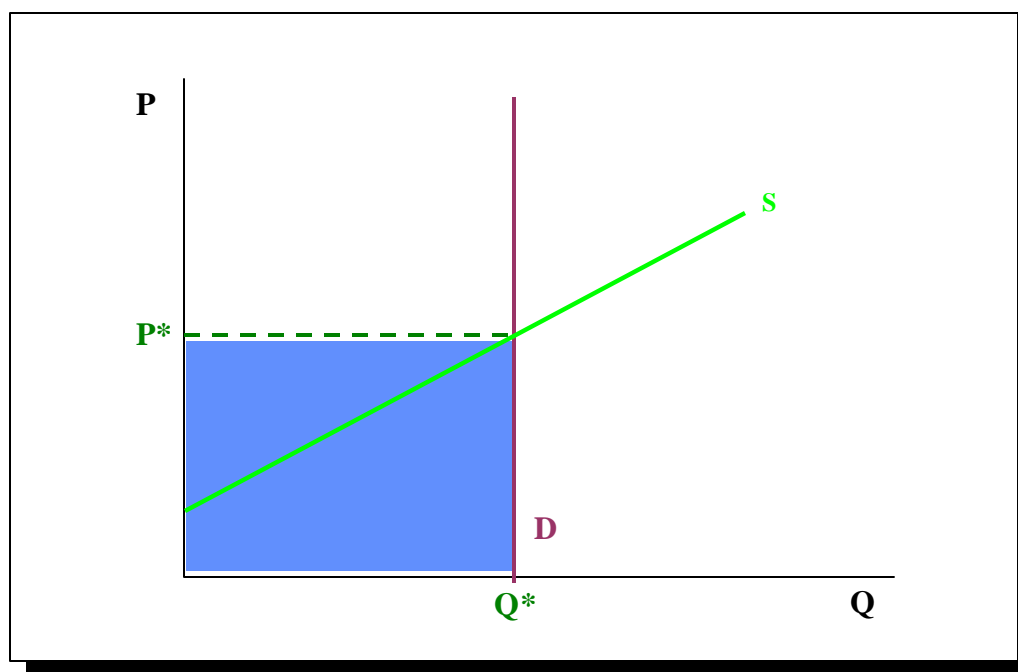
One of the more common proposals in the second camp is to pay each supplier its bid for the service it supplies.

- **Advocates of such proposals claim that it will reduce the amount that loads must pay for that service.**
- **But that claim is only valid if the generators do not change their bids in response to the ISO's change in the way it determines payments.**

Paying Bids

Let us return briefly to the stylized example of a market that we used at the beginning of the day.

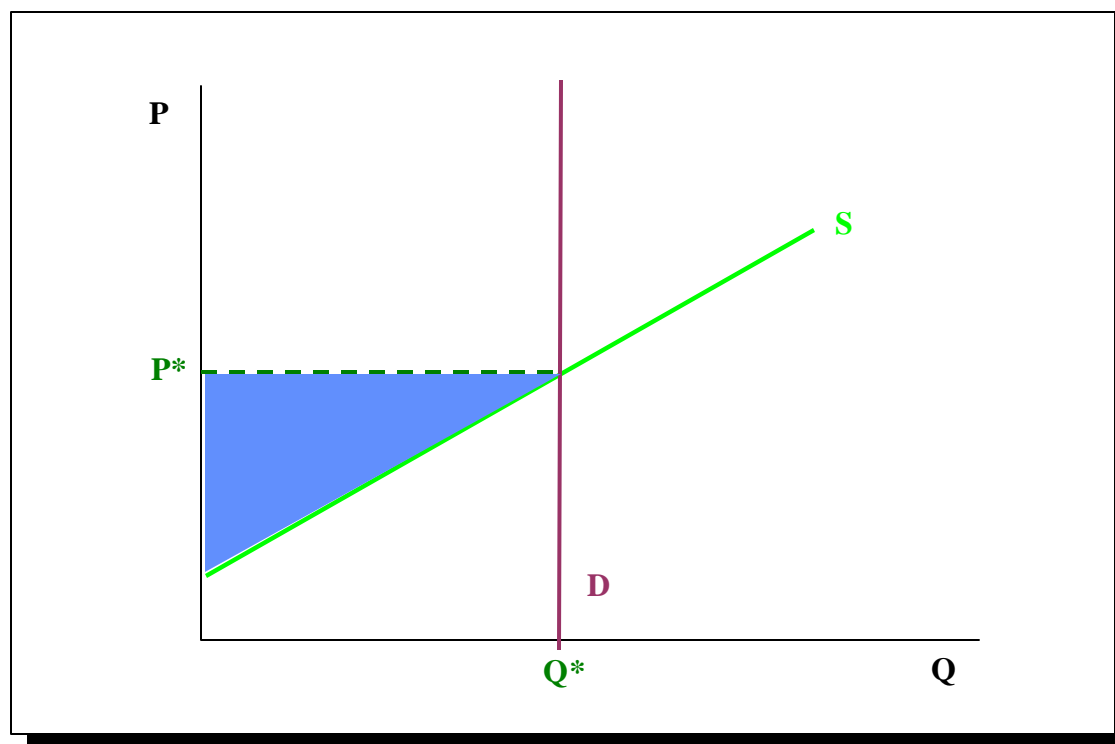
In this example, if all suppliers are paid the market-clearing price P^* , they have an incentive to bid their actual costs, because those costs do not affect the amount they are paid.



Paying Bids

If the RTO were instead to pay each generator its bid, then the RTO would reduce the amount it pays for ancillary services--if the generators do not change their bids.

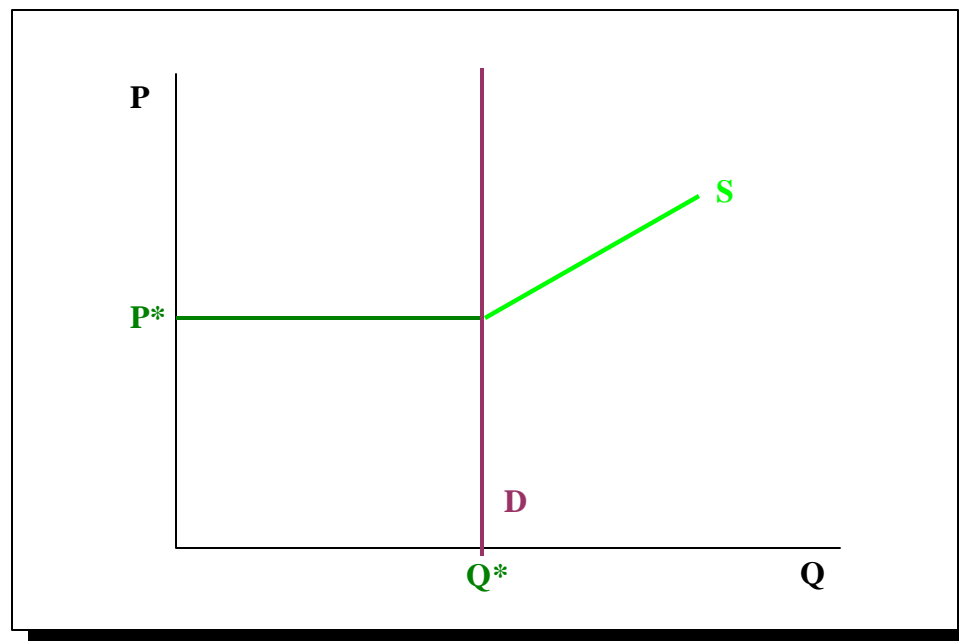
The amount that the RTO would save is illustrated by the shaded triangle below.



Generators' Response

But the generators that are selected to supply the service will respond by increasing their bids.

- Suppose for the moment that they all know that the bid submitted by the last supplier of the service selected will be P^* .
- In that case, all of these generators will bid P^* , and the RTO's attempt to reduce the amount it pays for the service will have no effect.



Generators' Response

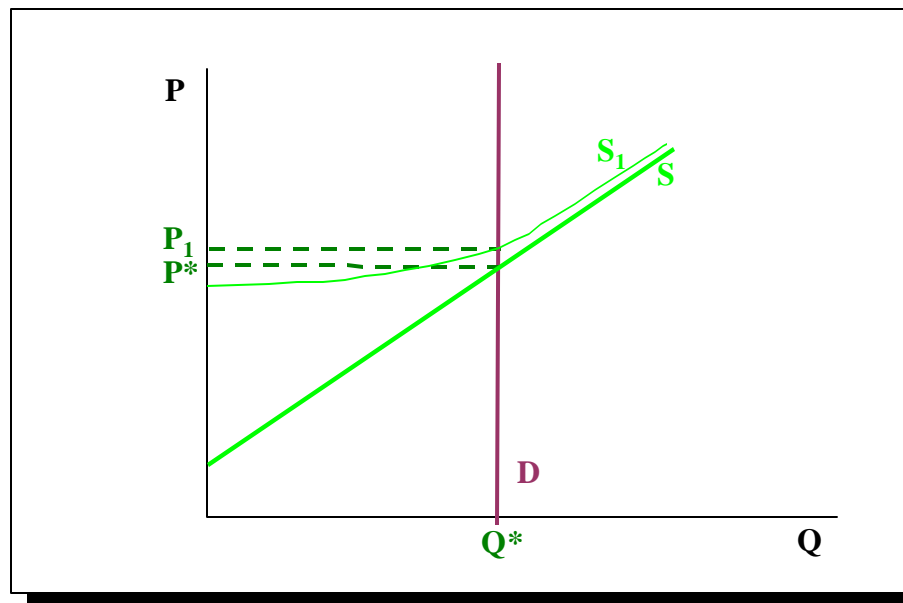
In reality, not all of the generators will know in advance that the last accepted bid for this service will be P^* .

- **Some of the generators whose actual cost is lower than P^* will bid lower than P^* .**
- **Some of the generators whose actual cost is lower than P^* will bid higher than P^* .**
- **But none of the generators will bid less than its actual cost.**

Inefficient Selection

As a result, the optimum mix of generators will no longer be selected.

- Some generators whose actual cost was less than P^* will bid above P^* and will not be selected as a result.
- But the generators who replace them will also have bid above P^* .
- As a result, prices will rise, and the RTO's efforts to reduce the cost of this ancillary service will backfire.



Efficiency and End User Costs

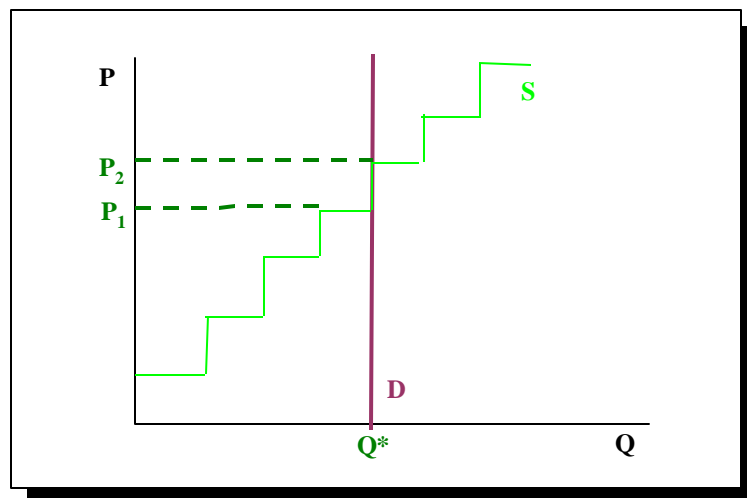
The RTO can only select the most efficient mix of suppliers if those suppliers have incentives to bid their actual costs into the market.

- In order for those suppliers to have such incentives, they must be paid the market-clearing price for the services they supply.
- When the bids these suppliers make affects they are paid, they have an incentive to skew their bids.
 - *The skewing of the bids will impair the efficiency of the market.*
 - *And, more often than not, it will increase the amount that end customers must pay*
- As a result, schemes that claim to reduce end-user prices through creatively calculating prices should be avoided.

Market-Clearing Prices

Market-clearing prices are the prices for which demand is equal to supply.

- There is discretion in selecting a procedure to select providers of an ancillary service.
- But there is generally very little discretion in selecting a procedure for calculating market-clearing prices, as usually only one price clears the market.
 - *The exception applies to cases in which the last increment of demand just meets the last increment of supply. Then a range of prices can clear the market.*



Market-Clearing Prices

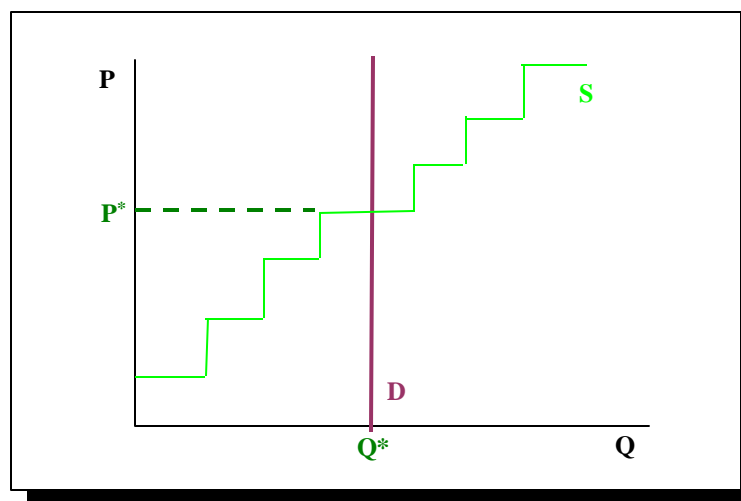
It is easiest to illustrate how market-clearing prices are calculated when:

- **Demand for the service is fixed.**
- **No locational constraints bind.**
- **Ancillary services markets are conducted independently.**
- **There is a single bid parameter.**

Calculating Market-Clearing Prices

In that case, the market-clearing price for the service is simply the highest accepted bid to supply the service.

- This price clears the market because all bidders who bid above the market-clearing price do not want to supply the service at that price.
- All bidders who bid below the market-clearing price want to supply the service at that price.
- Therefore supply is equal to demand, and the market clears.

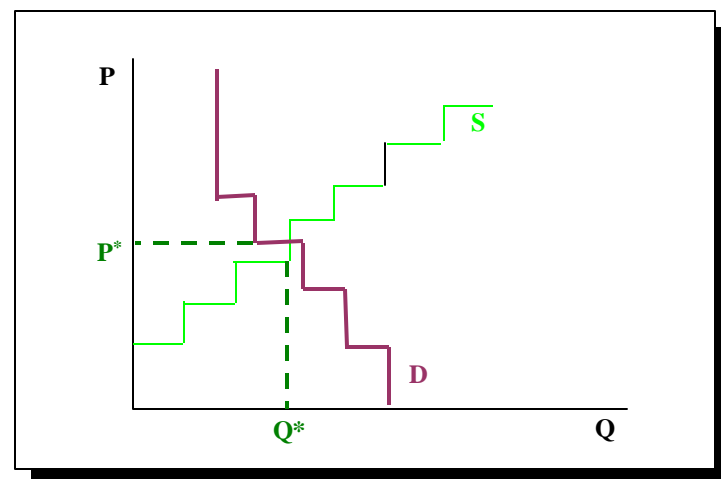
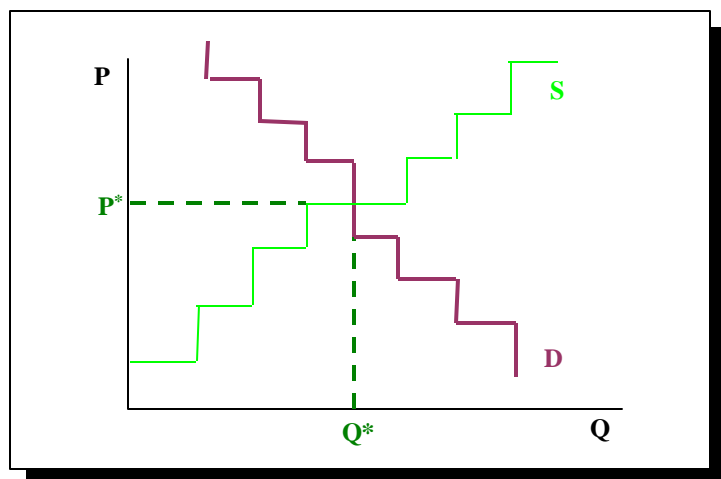


Pricing When Demand Is Flexible

If demand is permitted to vary with price, the market-clearing price will be equal to:

- The highest bid to provide the service that was accepted, if a supplier is on the margin, or
- The lowest bid to purchase the service that was accepted, if a purchaser is on the margin.

Either of these prices will clear the market, as the graphs below illustrate.



Pricing When Locational Constraints Bind

When locational constraints bind, uniform prices will not be able to clear markets. There are generally two ways of determining a uniform price in such circumstances, each with its drawbacks.

- **One way is to calculate an “unconstrained price”, and then pay each supplier the greater of the unconstrained price or its bid.**
 - *Suppliers in constrained areas, are therefore paid their bids.*
 - *This encourages them to increase their bids, which has the disadvantages discussed earlier.*
- **The other way is to pay all suppliers a single price, which is the highest accepted bid.**
 - *This price is above the amount that is required to clear the market in constrained-down areas.*
 - *As a result, more of the service will be offered in those areas than is needed.*
 - *The RTO will have to resort to a non-price mechanism of selecting suppliers in such areas, which almost certainly will engender inefficiency.*

Pricing When Locational Constraints Bind

To illustrate the calculation of locationally varying market-clearing prices, consider the following example.

- **Suppose that the following generators submit the following bids to provide operating reserve:**
 - *Generator E1, which is located in the East, offers 50 MW at \$1/MW.*
 - *Generator E2, also located in the East, offers 50 MW at \$2/MW.*
 - *Generator W1, which is located in the West, offers 50 MW at \$5/MW.*
 - *Generator W2, also located in the West, offers 50 MW at \$6/MW.*
- **Also suppose that demand for operating reserve is fixed at 80 MW, at least 40 MW of which must be provided by Western suppliers due to transmission constraints between the West and the East.**

Pricing When Locational Constraints Bind

The most efficient way to provide operating reserve is for:

- **Generator E1 to provide 40 MW of operating reserve, and**
- **Generator W1 to provide 40 MW.**

The total cost of providing this service is:

$$40 \text{ MW} \times \$1/\text{MW} + 40 \text{ MW} \times \$5/\text{MW} = \$240.$$

The 80 MW operating requirement could be provided less expensively by replacing reserve provided by Generator W1 with reserve provided by an Eastern generator.

But doing so would violate the constraint requiring at least 40 MW of operating reserve to be located in the East.

Pricing When Locational Constraints Bind

The market-clearing price of operating reserve in this example is \$1/MW in the East, and \$5/MW in the West.

- If the price were greater than \$1/MW in the East, then Generator E1 would want to supply more than 40 MW, and Generator E2 might also want to supply operating reserve.
- Therefore, the market would not clear, since there is only 40 MW of operating reserve demanded in the East.
- If the price were less than \$5/MW in the West, then Generator W1 would not want to supply any operating reserve.
- Therefore, the market would not clear, since there is demand for 40 MW of operating reserve located in the West.

Similar arguments can be used to show why the market-clearing price in the East must be at least \$1/MW, and the market-clearing price in the West must be no more than \$5/MW.

Pricing When Locational Constraints Bind

Because constraints on the location of ancillary services are usually stated on a zonal basis, the number of prices would not exceed the number of zones.

- **However, it is possible that the development of competitive markets will force more precision on ancillary services requirements.**
- **This could change the way in which locational requirements for ancillary services are specified.**

Transmission prices should also reflect the value of using transmission capacity to deliver ancillary services from one location to another.

Pricing When Locational Constraints Bind

Note that the market-clearing price for a zone is not necessarily equal to the highest accepted bid to provide that service from a supplier located in that zone.

- **To see this, modify the preceding example so that Generator C, located in the Central region, offers 10 MW of operating reserves at \$0.50/MW.**
- **The requirement that a total of 80 MW of operating reserves must be purchased stays in place.**
- **So does the requirement that at least 40 MW of those reserves must be located in the West.**

The most efficient solution is to select the 10 MW of reserves from Generator C, 30 MW of reserves from Generator E1, and 40 MW of reserves from Generator W1.

Pricing When Locational Constraints Bind

The market-clearing price for operating reserves in the East and in the Central Region should still be \$1/MW.

- **This is because reserves in the Central region and in the Eastern region can be substituted for each other on the margin.**
 - *An additional MW of either counts towards the total operating reserve requirement.*
 - *An additional MW of neither would count towards the Western operating reserve requirement.*
 - *From the perspective of the operating reserve market, they are identical.*
- **Therefore, the relevant market is the market for Eastern or Central reserves.**
 - *This market clears at a price of \$1/MW, so that is the price that should apply to both regions.*

Pricing When Locational Constraints Bind

If the price for the Central region were set at the highest accepted bid in that region, \$0.50/MW:

- **Generator C would have an incentive to increase its price to \$1/MW.**
- **It would continue to be selected if it bid just under \$1/MW, since the least expensive resource which can replace it, Generator E1, has bid \$1/MW.**
- **So if Generator C correctly forecasts the true market-clearing price, the amount it is paid would be unaffected.**
- **Instead of making Generator C guess this price, it is more efficient to calculate market-clearing prices correctly and pay market-clearing prices.**

Economists call this the law of one price:

- **Commodities that are perfectly substitutable for one another on the margin should have the same price in equilibrium.**

Procedures Currently in Use

The record of other markets on these issues is mixed.

- In general, most markets pay market-clearing prices for most services when competitive markets have been established for those services.
- But prices are only sometimes calculated on a locational basis when locational constraints bind.
 - *California pays suppliers zonal prices for ancillary services.*
 - *New York has locational pricing for some services, and is introducing locational pricing for some other services.*
 - *Prices calculated in NEPOOL, Ontario, and PJM usually do not reflect location.*
 - *IndeGO committed to reflect congestion costs in ancillary service prices; but IndeGO also proposed to use the highest bid in each zone to set prices.*

Pricing When Services Can Be Substituted

The law of one price has other applications when it comes to the determination of market-clearing prices.

- **For example, when one ancillary service is substituted for another, the market-clearing prices for those services should be the same.**
- **Both the simultaneous method of selecting providers and the demand substitution version of the sequential method permit higher-quality services to be substituted for lower-quality ones, if it is less costly to do so.**
- **Therefore, this rule is applicable to markets conducted using either procedure.**

Pricing When Services Can Be Substituted

Suppose operating reserve requirements are set as follows:

- **At least 1000 MW of operating reserve must be acquired in the market.**
- **At least 500 MW of those reserves must be spinning.**
- **However, 600 MW of spinning reserve are purchased in the market due to the low bids they have submitted, so the constraint that requires at least 500 MW of reserves to be spinning does not bind.**

Pricing When Services Can Be Substituted

The market-clearing prices of spinning and non-spinning reserves should be the same, because:

- **An incremental MW of spinning reserves would reduce the amount of reserve that needs to be purchased by 1 MW.**
- **An incremental MW of non-spinning reserves would have the same effect.**
- **Since each category of reserves has the same effect, on the margin, their prices should be the same.**

Pricing When Services Can Be Substituted

California would calculate the prices separately for each market.

- **As a result, the price paid to the spinning reserve providers might be lower than the price paid to non-spinning reserve providers in this example.**

This procedure is motivated by a desire to reduce the amount paid for these resources.

- **However, recall that this was also the motivation for proposals for paying suppliers the amount they bid.**
- **It is subject to the same criticism as was that proposal-- spinning reserve providers should increase their bids in response.**
- **They will bid their expectation of the market-clearing price of non-spinning reserve.**
- **If they guess wrong, more expensive suppliers might be selected, increasing costs instead of decreasing them.**

Prices that Clear Markets

The general rule here is that the price that a supplier of a service should be paid is the market-clearing price, which is the amount bid by the resource to provide the service which, on the margin, would replace that supplier.

- **This is not the amount that supplier bid.**
- **It is not necessarily the highest bid submitted by a selected supplier in that supplier's zone, if locational constraints do not bind.**
- **It is not necessarily the highest bid submitted by a selected supplier of that service, if that service has been used to substitute for another service.**

Using Prices That Don't Clear Markets

All this may seem complicated, since market-clearing prices could need to take both locational constraints and interactions between markets for different services into account.

But consider the alternative, which is to pay some other price.

- **Since that price does not clear markets, supply is not equal to demand.**
- **If supply at that price is greater than demand, then some method must be used to determine which suppliers are actually selected.**
 - *This will be inefficient and will invite gaming.*
- **Alternatively, if supply at that price is less than demand, then additional suppliers will need to be selected, and paid something greater than the price.**
 - *This will also be inefficient and will invite gaming.*

The simplest solution is to use market-clearing prices.

Facilitating Self-Supply

Calculating market-clearing prices in this way will also facilitate self-supply of ancillary services, which the RTO intends to promote.

- **This will ensure that the price of higher-quality services will be as high or higher than the price of lower-quality services.**

Consider Company X, which is required to supply 25 MW of regulation and 25 MW of operating reserves, but which has 50 MW of capacity that is well suited to provide regulation.

- **Company X could simply self-supply 25 MW of each service, but this would under-utilize its valuable regulation capacity.**
- **Self-supply rules could be written so that Company X is required to provide 50 MW of regulation or operating reserve, at least half of which must be operating reserve.**
 - *This would permit this entity to self-supply 50 MW of regulation, but this rule provides it no incentive to do so.*

Facilitating Self-Supply

Another approach gives Company X an incentive to make its regulating capability available for regulation:

- **Company X would be permitted to offer to self-supply 50 MW of regulation.**
- **It would be paid the difference between the market-clearing price of regulation and the market-clearing price of operating reserves for the 25 MW not needed to meet its regulation requirement.**

But Company X would take a risk if the price of regulation might be lower than the price of operating reserve, even though regulation is used to substitute for operating reserve.

- **Calculated using a method that ensures this does not happen will encourage Company X to make this resource available.**
- **Otherwise, Company X will be better off if it takes those 25 MW to the market, and bids strategically.**

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Which Markets Can Be Made Competitive?

Order 2000 requires RTOs to “promote the development of competitive markets for ancillary services wherever feasible.”

What determines whether a competitive market is feasible?

- **The fundamental concern is market power.**
 - *If it is necessary to purchase a resource from an entity, or that resource controls enough of the supply of a resource that it can increase its profits by withdrawing capacity, then it has market power.*
- **Market power can arise for several reasons.**
 - *It may arise because a single entity--or a few entities--own a large share of all the resources capable of providing a service.*
 - *Or it may arise because there are locational constraints that require a certain amount of a service to be provided by resources within a given area, and ownership of the resources capable of providing that service in that area is concentrated.*

Markets That Are More Difficult to Make Competitive

Some services are more susceptible to these concerns than others.

- **Voltage Support and Reactive Power**
 - *Often a single generating plant (or other resource) must supply VARs.*
 - *Owners of such plants do not face any competition.*
- **Black Start Capability**
 - *Participants are determined through system restoration plans.*
 - *This makes it difficult for new suppliers to enter the market.*

As a result, alternatives to competitive procurement for these services may be necessary.

Market Mechanisms and Market Power

The best way to deal with market power is to adopt market mechanisms that minimize opportunities to exercise market power, and which facilitate the RTO's ability to identify market power when it is exercised.

Such market mechanisms:

- **Are transparent, in that prices for providing a given service are clearly visible and are calculated in the same way for all participants.**
- **Give all participants as much opportunity to compete in as many markets as possible, rather than forcing them to make arbitrary choices regarding which markets they wish to compete in.**
- **Do not give informational advantages to large players, by making market participants guess costs over which they have little control.**

Additional Measures to Combat Market Power

In addition, introducing demand curves for ancillary services will limit the opportunity to exercise market power.

However, these mechanisms will not always suffice. In those cases, the following modifications to procedures for selecting suppliers have been proposed:

- **Long-term contracting**
- **Cost-based bidding**
- **Administratively determined payments**
- **Price caps**
- **Monitoring**
- **Restructuring**
- **Divestiture**

Long-Term Contracting

While the market for a service may be uncompetitive over a short time scale, it may be more competitive if the time period for which the service is purchased is extended.

- **For example, the market for voltage support for the next day may be uncompetitive, because only one resource may be able to provide the required service.**
- **But it might be possible to award contracts for voltage support on a competitive basis if those contracts are defined over longer time periods.**

Long-Term Contracting

The ability to create competitive markets through long-term contracting is subject to several caveats.

- **The lead time before the contract starts needs to be sufficient to permit entities that are not currently in the market to enter the market.**
- **The contracts need to cover a long enough term that suppliers will be willing to enter the market.**
- **There may still be potential for the exercise of market power after the expiration of the original contract.**
- **There is still the issue of how to select suppliers in the time period leading up to the start date of the long-term contract.**
- **Finally, if an entity has long-term market power, then awarding long-term contracts for the supply of a service will not alleviate its market power.**

Long-Term Contracting

IndeGO proposed that suppliers of reactive power and voltage support be signed to long-term contracts.

- **If entry is a possibility, and that entry would permit alternative sources of reactive power and voltage support to enter which could replace the support supplied by incumbent generators, then this proposal could facilitate competition.**

If this proposal does not facilitate entry, or the entrants cannot displace the incumbents, then it would not be sufficient to supply competition.

- **If there is market power in the short term, and no entry, there will be market power in the long term as well.**

Cost-Based Bidding

In that case, requiring all suppliers with market power to submit cost-based bids is an option.

- **However, cost-based bidding does not give suppliers incentives to reduce costs.**
- **Schemes to supply such incentives are plagued by arbitrariness.**
- **Additionally, this procedure is inherently discriminatory, since it pays more to high-cost suppliers than to low-cost suppliers.**

Administratively Determined Prices

Another option is for the market operator simply to announce a price, and let suppliers select themselves: all who wish to supply a service at that price may do so.

- **Again, the determination of which price to offer is arbitrary, and rife with potential for manipulation.**
- **The quantity of the service supplied will almost certainly be either more or less than the RTO truly needed.**
 - *Methods to work around this, such as pro-rating requests to supply the service, simply encourage gaming to evade the restrictions.*
- **Finally, it does not solve the problem. An entity with market power still has market power, and can decline to offer the service if the price is not sufficient.**

Price Caps

An alternative which has been used in several different areas, especially California, is price caps.

- **Price caps may be a short-term remedy, but they have a number of problems.**
 - *They do nothing to address long-term problems with market competitiveness.*
 - *They permit market power to continue to be exercised--they simply bound the exercise of that market power.*
 - *And they prevent prices from reaching very high levels when they should do so in the context of a fully competitive market.*

Market Monitoring

The RTO can monitor behavior, and sanction those who attempt to exercise market power.

- **The effectiveness of this approach depends critically on the structure of the market.**
- **Some ways of structuring the market can make it virtually impossible to distinguish between:**
 - *Bidding strategies intended to exercise market power, and*
 - *Bidding strategies necessitated by market rules which discourage entities from bidding their costs.*

Divestiture

Finally, in some cases of pronounced long-term market power for which no other ready remedy appears, the entity that possesses the market power has been sometimes been required to divest part of its holdings.

- **Such divestitures may occur in parts, in order to guard against transferring market power to the acquiring entity.**

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Incentives for Suppliers to Meet Obligations

Suppliers of an ancillary service should be required to demonstrate that they are physically capable of providing the service before they are allowed to offer that service.

- **But they still must have some financial incentive to meet their obligations.**

The system of incentives adopted should:

- **Ensure that entities only offer to perform a service that they actually intend to supply.**
- **Not discourage potential suppliers through draconian penalties.**
- **Reward those who exceed standards, as well penalizing those who fall short.**

Calculating Incentives and Penalties

There are several ways to calculate these incentive and penalty payments. In general, they entail multiplying a quantity by a price.

- **Ideally, the quantity would be based on supplier performance.**
 - *A measure of the supplier's actual performance would be compared to the service it was supposed to perform.*
 - *To the extent that its measured performance differs from that standard, the difference would be used to calculate any incentive or penalty payments.*
- **The price would be based on the value of that service, as determined in markets.**
 - *If a supplier defaults, and it is possible to replace the service, then the price at which the replacement resource was obtained would be used to calculate any penalties.*

In practice, this combination is only occasionally observed.

- **New York's regulation market.**

Standards and Metrics

The major problem has been the lack of well-defined standards and metrics that:

- **State what the provider of an ancillary service is required to do.**
- **Quantify the extent to which that service has been performed.**

Consider the following questions:

- **Suppose that a supplier of 10-minute operating reserve does not respond to a reserve pick-up, but the reserve pick-up is canceled after 8 minutes. Has that supplier complied with its responsibility?**
- **How much time should a regulation supplier be given to respond to a change in its AGC signal?**

In most markets, the answers to these questions are vague.

Standards and Metrics

Competitive pressures will mean that system operators will no longer be able to assume that suppliers will perform as requested.

- **Instead, standards must be developed that explicitly define how suppliers of ancillary services are expected to perform.**
- **Performance standards should be:**
 - *Based on the expectations used by the RTO when it determines the amount of that ancillary service that is required.*
 - *Consistent with control area operators' obligations under NERC guidelines, and under any other applicable criteria.*
 - *Consistent with whatever inter-control area coordination procedures are adopted to foster the development of RTO-wide ancillary services markets.*
- **NERC Policy 10 provides some guidance.**

Administrative Determination of Penalties

Due to the vagueness of standards and the lack of good metrics, quantities are often determined administratively in other markets.

- **Incentives may also be tied to performance during tests, rather than a supplier's actual performance.**

Prices may also be determined administratively.

- **The use of market-clearing prices to determine penalties is more common, particularly in operating reserves markets.**
- **Obviously, this approach is more difficult if there is no market-clearing price to refer to.**

Lack of Performance Incentives

Finally, suppliers almost never receive increased payments for performing better than expected.

- **As a result, they have no incentive to exceed standards.**
 - *Therefore, they have no incentive to decrease the amount of each service that the RTO requires.*
 - *This effectively limits individual suppliers' ability to provide that service, which leads to inefficiency.*
- **Incentive payments and penalties should be tied to unit's actual performance relative to these standards.**

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Allocating the Responsibility to Provide

The responsibility to supply ancillary services (or to purchase them in the market) can be allocated in many ways:

- **To loads (or their agents) based upon:**
 - *Energy consumed on peak (demand charges)*
 - *Energy consumed overall (energy charges)*
- **To generators (or their agents) based upon:**
 - *Energy produced*
 - *Generating capacity*

Or they can be allocated to generators and/or loads, based upon their effect on the amount of the service needed.

Allocating the Responsibility to Provide and Market Efficiency

The procedures used to allocate this responsibility to supply ancillary services can have a significant effect on market efficiency.

- If the actions of individual market participants affect the need for this service,
- But they are not charged the cost of the services made necessary by their actions,
- Then there will be a greater need for the service than there would be in an efficient market.
 - *Since some customers can shift costs to other customers, the incentive for them to act in a way that limits the need for the service is muted.*
- Market participants who have a significant effect on the need for a service will have little incentive to to modify their behavior.

Cost Shifting Via Inaccurate Allocation

Consider the following example:

- **An arc furnace, with its large and rapid swings in consumption, causes 50 percent of the regulation requirements in a control area.**
- **Yet it is only 5 percent of the load in its area.**
- **If the regulation requirement is distributed among loads based on the amount they consume, then it will only be allocated 5 percent of the regulation requirement.**
 - *It only bears the cost of 10 percent of the regulation burden it causes.*
 - *The remaining costs would be shifted to other customers.*
- **If the arc furnace's responsibility had been based on its contribution to total regulation requirements:**
 - *It might have modified its operations in order to reduce its effect on regulation requirements.*
 - *Even if it did not, other customers would not have been forced to subsidize the arc furnace.*

Increasing Efficiency Through Correctly Allocating Responsibility

The regulation requirement results from:

- **Loads that change consumption levels quickly.**
- **Generators that do not follow schedules.**

Consequently, allocating the regulation requirement to entities that have caused the regulation requirement to be what it is, in proportion to their effect on the regulation requirement, will lead to greater market efficiency.

- **It will also make the existence of a balancing market for regulation services more important, since it will make it more difficult for each market participant to predict its regulation requirement.**
- **Some residual portion of the requirement may remain to be allocated.**

Similar arguments can be made for some other services.

Allocating Responsibility When Causality Is Unclear

It will not always be possible to assign responsibility for causing the need for a service.

In such cases, the economically efficient way of allocating that responsibility is to do so in the least distortionary way possible.

- **A “distortionary” procedure is a procedure that affects market participants’ actions.**

In most cases, the least distortionary way of allocating these responsibilities that is also considered to be fair is to allocate them to load, either on an energy or a demand basis.

Procedures Currently in Use

In most current ancillary service markets,

- The requirement to provide a service, or the costs associated with purchasing that service in the market, is allocated to loads (or export/wheel-through customers), based on the energy consumed by those loads.

But there are exceptions.

- Imbalances markets.
 - *Charges for energy imbalances are always proportional to the user's effect on the need for this service.*
 - *The effects on incentives are obvious.*
- New York's regulation market.
- California's replacement reserves market.

Responsibility that Varies with Time and Location

Additionally, recall that the cost of providing an ancillary service may vary both from place to place and from time to time.

The procedure used to allocate responsibility for providing ancillary services to different entities should take this into account.

- **Cost shifts similar to those described earlier can result if:**
 - *The allocation of ancillary services obligations to individual market participants does not take into account the location at which different entities cause ancillary services to be required.*
 - *The allocation of ancillary services obligations to individual market participants does not take into account the time at which different entities cause ancillary services to be required.*
- **Markets are currently more likely to take the second of these requirements into account, with temporally varying ancillary services requirements or charges.**

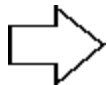
Allocating Responsibility Based on Schedules

Finally, to the extent possible, responsibility to provide ancillary services should be based on actual activity, as opposed to scheduled activity.

- **Therefore, if responsibility is allocated to loads on an energy basis, it should be based on the actual amount of energy consumed, rather than scheduled consumption.**
- **If each load's ancillary services requirement is based on its scheduled consumption, it will have an incentive to understate its schedule.**
- **This will shift costs, and could lead to reliability problems and inefficiency.**

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Interim Market Design

Even if there were agreement now regarding the optimal end-state structure of ancillary services markets, it is unlikely that they could be implemented as of the date of RTO formation.

- **The focus of this section is on the questions that need to be addressed in time for this fall's RTO filing, regarding market features that must be in place as of RTO start-up.**
- **But we also need to keep end-state objectives in mind: the end-state design should not be driven by the interim design.**

Control Areas

The first questions you must answer are:

- **How will control areas be defined?**
- **How will the different control areas in the RTO coordinate operations to facilitate the development of RTO-wide ancillary services markets?**

The answers will depend on the short-term ability of control area operators to modify current operating procedures.

Market Power Assessment

The next question is whether a competitive market can be defined for this service.

- **The markets for some ancillary services (either RTO-wide, or in some areas) may not be competitive.**
 - *This may be a bigger problem for some services than for others.*
- **If not, then it will be necessary to apply one or more of the market power mitigation measures previously described to such markets.**

Services Offered

The next questions pertain to, “Which markets can be implemented in the time frame available?”

In order to implement a market for a service, it will be necessary to:

- **Define standards for providers of that service.**
- **Define a mechanism for determining whether providers have met those standards.**

If agreement cannot be reached on these points, or if the necessary metering or communications infrastructure will not be available in time, then it will be difficult to define competitive markets for that service.

Market Development

At this point:

- **You will have defined which services can be offered.**
- **You will have defined the areas to which each market applies.**

The next issue is to proceed to developing each of the markets, including:

- **Procedures for selecting providers.**
- **Procedures for calculating prices.**
- **Allocating responsibility for providing services.**

Software development issues are likely to affect your ability to implement the desired end-state solution immediately, so it may be necessary to use simplified answers to these questions early in the RTO's life. However, it will be important to have some vision of the end-state solution when designing interim solutions.